



*Space Technology Mission Directorate
Game Changing Development Program
FY15 3rd Quarter Review*

**Next Generation Life Support (NGLS)
Charts for GCDP “Smart Book”**

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07/20/2015



Smart Book Charts

<These charts feed Smart Book and all charts are required. Please review questions on the next chart to ensure proper data control>

<Only update these charts if there have been changes since the STI review was completed>



Data Release



Please answer the questions below:

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NGLS High Performance EVA Gloves



- STATUS QUO**
- Current glove life is limited to only 25 EVAs
 - Outer glove layers need repair after only 2-5 uses
 - Cut gloves on orbit have led to design changes that increase cut resistance but severely limit mobility
 - Current glove mobility is limited to only 20% of bare hand mobility leading to decreased EVA efficiency and increased hand injuries

PROBLEM / NEED BEING ADDRESSED

Future human exploration missions cannot be performed with existing spacesuit technologies. Specifically, current EVA gloves are life-limited and severely limit hand mobility.

PROJECT DESCRIPTION/APPROACH

- Recent developments in materials will be explored for application to glove designs, with a focus on materials which will increase current glove durability and mobility.
- Through collaboration with the Human Research Program (HRP), the project team will research injury mechanisms associated with current EVA gloves and identify areas where technology development can significantly reduce injury and improve performance.
- Additional areas of improvement that will be addressed with new technology include dust management, damage mitigation, thermal insulation, and bulk and weight reduction.
- Lessons learned through research will be fed into concepts for improving glove performance while minimizing injury during future training and flight.
- Final product is a pair of gloves that will be used with the AES advanced suit.

QUANTITATIVE IMPACT

- Decreased exertion required to complete complex, hand-intensive EVA tasks:
 - Provide 60% of bare hand performance
- Reduce the risk of astronaut injury during training and flight
- Increase glove life beyond 25 EVAs
 - Increase outer layer uses beyond 10 EVA's

PROJECT GOAL

- Develop advanced EVA gloves to enable future human exploration missions
 - Gloves will be compatible with exploration mission requirements and the advanced spacesuit being developed by NASA
- Increase technology readiness level of advanced EVA gloves to TRL5
 - Infuse glove technology with the advanced space suit currently being developed and perform integrated test

- NEW INSIGHTS**
- NASA is designing a next generation suit for EVA, but plans to use current glove technology (20+ years old)
 - Current gloves are not nominally designed for increased operating pressures baselined for future missions
 - Future exploration missions will be conducted in more challenging environments
 - Recent material developments in memory-shaping alloys and moldable, breathable bladder materials will improve fit and mobility while reducing injury risk

NGLS High Performance EVA Glove Overview



Elevator Statements

- Future human exploration missions cannot be performed with existing spacesuit technologies. Current EVA gloves have limited life, severely limit hand mobility and are a significant source of injury during spaceflight.
- Current gloves are not designed for increased operating pressures and the more challenging environments expected.
- In collaboration with HEOMD's Human Research Program, we are researching mechanisms for hand injury and will be developing new gloves to significantly reduce injury and improve performance, including mobility and glove life.

Partnerships, Integration with other Programs

- NIAC – (Indirectly partnering)
 - NIAC recipient was eligible to respond to RFP for Mechanical Pressure Glove
- HEOMD – Advanced Exploration Systems
 - Customer and co-funding 1 FTE and 1 WYE each year
- HEOMD – Human Research Program
 - Analysis of Injury databases, flight injury questionnaire & sensor glove development
- Industry and Academia
 - RFP for pressurized glove. Awarded to ILC – Dover
 - Robotic Assist Glove in cooperation with HRS and GM

Technology Infusion Plan:

- MI: A Mission Usage Agreement was signed between NGLS/GCDP and the Advanced Space Suit Project/AES/HEOMD on September 24, 2014.
- There are three potential customers for high performance EVA gloves: The Advanced Space Suit Project, Modified ACES/Asteroid Retrieval Mission, and ISS Program.
- The AES Advanced EMU Project is providing financial support to the HPEG Project Element in the form of 1 FTE and \$250k procurement each year for FY 2012-2016
- New TRL 5 gloves will be transitioned to AES to support Z-3 thermal vacuum chamber testing in 2018.

Key Personnel:

Program Element Manager: Kevin Kempton

Project Manager: Daniel Barta

Project Element Lead: Sarah Walsh

Lead Center: JSC

Supporting Centers:

NASA NPR: 7120.8

Guided or Competed: Guided with competed contracts

Type of Technology: Pull

Key Facts:

GCD Theme: Affordable Destination Systems & Instruments (ADSI)

Execution Status: Year 2 of 3

Technology Start Date: October 1, 2014

Technology End Date: September 30, 2016

Technology TRL Start: 3

Technology TRL End: 5

Technology Current TRL: 3

Technology Lifecycle Phase: Implementation

NGLS Spacecraft Oxygen Recovery



PROBLEM / NEED BEING ADDRESSED

Develop spacecraft atmosphere revitalization technologies that will increase closure of the atmosphere revitalization loop (TA-06).

PROJECT DESCRIPTION/APPROACH

- Develop advanced technologies for further recovery of O₂ from CO₂ to approach full closure of spacecraft ARS.
- Implement a competitive, phased approach utilizing the Game Changing Development NRA
- Initial Phase:
 - NRA appendix with descriptions of the technical challenge providing boundaries for the development space and for focusing the responses to maximize potential for infusion.
 - Initially awarded 1-yr contracts at \$450K to \$750K each.
 - Awardees must
 - Demonstrate basic functionality at a component or breadboard level in a laboratory environment (TRL 4)
 - Characterize performance against KPPs representative of the technology
- Second Phase (competitive down selection):
 - Select to two most promising technologies for continued development
 - Each funded at up to \$2M total over two years
 - Target maturation to at least TRL 5 by end of period of performance.
 - Implementation phase concludes with hardware delivery to NASA/AES
- Up to \$6.5M cost (\$2.5M Phase I, \$4M Phase II)
- 48 months (Phase I solicitation to Phase II delivery)

QUANTITATIVE IMPACT

- Increased oxygen recovery beyond the state of the art (42%) to at least 70% and approaching 100%.
 - Resultant savings: 275 - 334 lb oxygen per crewmember per year
- Reduced spacecraft resources (power, volume) for oxygen recovery
- Possibility of combining functions of O₂ generation with CO₂ reduction, simplifying ECLSS architecture.

PROJECT GOAL

- Phase I funding will advance technologies from TRL 3 to TRL 4.
- Phase II funding will advance technologies from TRL 4 to TRL 5.
- Delivery of hardware for infusion with AES ECLSS customers.
- Integrate hardware products with other ARS and ECLSS hardware leading to subsystem and system integrated testing.
- Contribute to ECLSS loop closure, reducing launch mass and increasing space vehicle self sufficiency, enabling long duration human exploration beyond LEO.

- The ISS Atmosphere Revitalization System (ARS) is not fully closed.
 - The ISS Carbon Dioxide Reduction System (CRA) is based on Sabatier reaction technology
 - Approximately 58% of oxygen is lost to space.
- Further closure of the ARS beyond SOA is necessary for long duration missions to reduce launch mass and increase spacecraft self-sufficiency.

- Reliable Closed Loop ECLSS is a top technical challenge and ARS is a high priority technology in TA-06.
- A number of technical approaches have promise to increase closure of ARS
 - Ion Exchange Membrane Electrolysis
 - Carbon Formation Reactors
 - Bosch Carbon Dioxide Reduction
 - Solid Oxide Electrolysis
 - Microfluidic Electrochemical Reactors
- These solutions provide additive capability to existing architecture or substitutional capability disruptive to the existing architecture

STATUS QUO

NEW INSIGHTS



NGLS SpaceCraft Oxygen Recovery (SCOR) Overview



Elevator Statements

- The state-of-the-art Atmosphere Revitalization Systems (ARS) on spacecraft such as the ISS are only partially closed. A significant amount of oxygen is not recycled and lost to space as unprocessed carbon dioxide.
- Further closure is necessary to reduce launch mass and increase space vehicle self sufficiency, enabling long duration human exploration beyond LEO.
- SCOR seeks to develop technologies that increase O₂ recovery beyond the SOA (42%) to at least 75% & approach 100%.

Integration with other projects/programs and partnerships

- HEOMD – Advanced Exploration Systems
 - Customer: AES Life Support Systems Project.
- SBIR
 - Phase III Umpqua (SBIR 2010-I X3.01-9783)
“Regenerative Bosch Reactor”
 - Phase III pH Matter (SBIR 2010-I X3.01-8790)
“Novel Catalysts for Continuous Operation Bosch Reactor”
- Industry and Academia
 - University of Texas – Arlington, University of Delaware, Umpqua Research Co.

Technology Infusion Plan:

- PC: A Mission Usage Agreement between NGLS/GCDP and the Life Support Systems Project/AES/HEOMD was signed 4/14/15
- AES has agreed to fund one of the four Phase I contract awards at a value of \$442,985 (Umpqua Research Company).
- Personnel from the AES Life Support Systems Project will be kept informed of Phase I progress and invited to key reviews.
- Phase I efforts will result in TRL 4 Engineering Development Units, which will be evaluated by NGLS then made available to AES.
- TRL 5 prototype oxygen recovery hardware will be transitioned to the AES Life Support Systems Project at the end of the Phase II contract efforts.

Key Personnel:

Program Element Manager: Kevin Kempton
Project Manager: Daniel Barta, Koorosh Araghi
Project Element Lead: Morgan Abney
Lead Center: MSFC
Supporting Centers: MSFC, GRC
NASA NPR: 7120.8
Guided or Competed: Competed
Type of Technology: Push/Pull

Key Facts:

GCD Theme: Affordable Destination Systems & Instruments (ADSI)
Execution Status: Year 1 of 4
Technology State Date: October 1, 2014
Technology End Date: September 30, 2018
Technology TRL Start: 2-3
Technology TRL End: 5
Technology Current TRL: 2-3
Technology Lifecycle Phase: Implementation



NGLS Rapid Cycle Amine (RCA) Swingbed



PROBLEM / NEED BEING ADDRESSED

Supply and servicing of ventilation components limits EVA duration and imposes mass requirements on crewed, NEO-class missions

PROJECT DESCRIPTION/APPROACH

- Advance EVA CO₂ removal technology to extend EVA capability for long duration missions
- Mature Rapid Cycle Amine (RCA) Swing Bed
 - Demonstrate and characterize CO₂ removal and humidity control capabilities
 - Using PLSS 2.0 test article:
 - Assess effectiveness of CO₂ removal and evaluate EVA duration
 - Quantify EVA interoperability and efficiency with RCA as part of an integrated PLSS
 - Confirm extent of elimination of consumables to recharge ventilation system (i.e. LiOH canisters and MetOx recharging)
 - Characterize EVA lifespan and environmental limitations with real-time on-back atmosphere regeneration, CO₂ removal, and humidity control
 - Quantify PLSS complexity reduction, e.g. elimination of the condensing heat exchanger, slurper, and rotary separator
 - Quantify support hardware complexity and reduction, e.g. elimination of MetOx regenerator.
- RCA technology will be developed as part of the Game Changing Technology Program and tested in demonstrations funded by the HEOMD Advanced Exploration Systems Program

QUANTITATIVE IMPACT

- Increase EVA cycle life, from 25 EVAs to 100+ EVAs
- Real-time, self-contained CO₂ elimination and humidity control
- Eliminate > 22 lbm of “on-back” PLSS components such as slurpers, rotary separators, and gas traps

PROJECT GOAL

- Develop PLSS components for a new Extravehicular Mobility Unit for Human Exploration
- Fabricate RCA 2.0, as the first full sized assembly
- Test RCA 2.0 in an integrated PLSS test article
- Perform environmental and life tests on RCA 2.0
- Design and fabricate RCA 3.0 as the first human rated prototype

- LiOH or MetOx provides CO₂ removal for EMU
- EVA duration depends on maintenance/replacement of consumables
- Separate systems for humidity control are required
- MetOx is regenerated on ISS in a special oven
 - Time (~ 14 hours) and power (> 1kW), dumps contaminants into ISS Cabin

- Amines can regenerate during EVAs using cyclic exposure to space vacuum
- Amine material controls both CO₂ and humidity
- Increased performance of new amines have allowed for smaller unit size & lower mass
- Reduces Portable Life Support System (PLSS) complexity by eliminating onboard components
 - Simplified thermal/fluid loops
 - No condensing heat exchanger or air/water separator will be required.
 - Increases safety and reliability



NGLS Rapid Cycle Amine (RCA) Swingbed Overview



Elevator Statements

- The RCA is a critical component under development for the next generation advanced space suit for human exploration beyond LEO. We are working closely with the Advanced Exploration System (AES) program for hardware infusion.
- The RCA regeneratively absorbs and desorbs CO₂ and humidity continuously during extravehicular activity (EVA). Mass savings will be significant - no beds to change out. EVAs will no longer be constrained in duration by the CO₂ removal system.
- CO₂ and humidity removal are provided by separate subsystems in the current suit on the ISS. The RCA reduces complexity, eliminating high maintenance hardware associated with moisture removal, including problematic air-water separators.

Integration with other projects/programs and partnerships

- HEOMD – Advanced Exploration Systems
 - Our chief customer is the AES Advanced Space Suit Project through its goal to develop the next generation space suit for human exploration missions beyond LEO.
- Industry and Academia
 - Our industry partner is United Technologies-Aerospace Systems, of Windsor Locks, CT

Key Personnel:

Program Element Manager: Kevin Kempton

Project Manager: Daniel Barta

Project Element Lead: Cinda Chullen

Lead Center: JSC

Supporting Centers: White Stands Test Facility

NASA NPR: 7120.8

Guided or Competed: Guided

Type of Technology: Pull

Technology Infusion Plan:

- MI: A Mission Usage Agreement was signed between NGLS/GCDP and the Advanced EVA Systems Project/AES/HEOMD 9/18/12.
- 2nd generation hardware (RCA 2.0) was infused in the PLSS 2.0 test article in FY13. Integrated testing was completed in FY14.
- PLSS 2.0 Human-in-the-loop Testing with RCA 2.0 was completed in December 2014.
- Third generation hardware (RCA 3.0) was delivered to the AES Advanced Space Suit Project in June 23, 2015 for incorporation into PLSS 2.5 and 3.0 for testing, raising the TRL to 6.
- The technology was successfully transitioned to AES July 9, 2015.

Key Facts:

GCD Theme: Affordable Destination Systems & Instruments (ADSI)

Execution Status: Year 4 of 4 (extended as FTE only task 4th year)

Technology State Date: October 1, 2011

Technology End Date: July 9, 2015

Technology TRL Start: 3

Technology TRL End: 5 (“TRL 6 ready” – once relevant environment testing is completed by AES customer)

Technology Current TRL: 5

Technology Lifecycle Phase: Completed and Transitioned

NGLS Variable Oxygen Regulator (VOR)



PROBLEM / NEED BEING ADDRESSED

Existing O₂ regulators limit the solution space required to optimize consumables, reduce crew fatigue, and ensure flexibility during long duration Mission EVAs.

PROJECT DESCRIPTION/APPROACH

- Advance EVA O₂ regulator technology to extend EVA capability in support of exploration missions
- Fabricate Variable Oxygen Regulator (VOR 2.0) for oxygen use and size for the Suitport compatible packaged PLSS 2.0 test article
- Assess VOR 2.0 performance and behavior as part of vacuum chamber tests of the packaged PLSS using N₂ as the working fluid and a metabolic simulator
- Assess VOR 2.0 for oxygen safety
- Conduct environmental performance tests, life tests, and develop regulator control algorithms.
- Design and fabricate VOR3.0 for testing as part of human-in-the-loop vacuum chamber tests with 100% oxygen as the working fluid.
- Integrate with flight fidelity control avionics
- Perform higher fidelity structural and materials analysis, oxygen safety evaluations, and develop flight ready interfaces
- Developed as part of the Game Changing Development Program and tested in demonstrations funded by the HEOMD Advanced Exploration Systems Program

QUANTITATIVE IMPACT

- Increase the number of Suit Pressure set points from 2 to 4000
- Vary pressure between 0 – 8.4 psid
- Tolerant to contamination (as high as 50 mg/ft²)

PROJECT GOAL

- Design and fabricate VOR 2.0 for O₂ compatibility
- Demonstrate VOR 2.0 in the PLSS 2.0 test article
- Test VOR 2.0 for O₂ compatibility
- Design and fabricate VOR 3.0 as Human Rated Prototype
- Develop PLSS components for a new Extravehicular Mobility Unit for Human Exploration

- EMU O₂ regulators have only two set points.
- Time consuming pre-breathe protocols are required
- Current regulator design works for limited vehicles and environments
- Decompression Sickness Treatment requires ancillary hardware

- Motor settable regulators provide ~4000 set points between 0 and 8.4 psid above ambient pressure
- Precise pressure set point control of the suit reduces crew fatigue & consumables
- Improves ability to interface with different vehicles
- Can be used to treat decompression sickness

STATUS QUO

NEW INSIGHTS

2015 GCD 3rd Quarter Review

NGLS Variable Oxygen Regulator (VOR) Overview



Elevator Statements

- Our pressure regulator allows, for the first time, continuous control of suit pressure, resulting in higher levels of flexibility and safety for extra-vehicular activity.
- Pre-breath protocols can be performed within the suit, decreasing preparation time & allowing for more rapid deployment.
- The suit will have flexibility to integrate across various spacecraft and missions of the future, regardless of cabin pressure.
- The regulator has been designed with safety first. It is robust and tolerant of contamination. It will withstand combustion events and retain enough capability after failure to return an astronaut back to the spacecraft safely.

Integration with other Projects/Programs and Partnerships

- HEOMD – Advanced Exploration Systems
 - Our chief customer is the AES Advanced Space Suit Project through its goal to develop the next generation space suit for human exploration missions beyond LEO.
- Industry and Academia
 - Our industry partner is Cobham Life Support, of Orchard Park, NY

Technology Infusion Plan:

- MI: A Mission Usage Agreement was signed between NGLS/GCDP and the Advanced EVA Systems Project/AES/HEOMD on September 18, 2012.
- 2nd generation hardware (VOR 2.0) was infused in the PLSS 2.0 test article in FY13. Integrated testing was completed in FY14.
- PLSS 2.0 Human-in-the-loop Testing with VOR 2.0 was completed in December 2014.
- Third generation hardware (VOR 3.0) was delivered to the AES Advanced Space Suit Project April 16 (unit 001) & May 26 (unit 002) 2015 for integration into PLSS 2.5 and 3.0, raising the TRL to 6.
- The technology was successfully transitioned to AES May 28, 2015.

Key Personnel:

Program Element Manager: Kevin Kempton
Project Manager: Daniel Barta
Project Element Lead: Marlon Cox
Supporting Centers: White Sands Test Facility
NASA NPR: 7120.8
Guided or Competed: Guided
Type of Technology: Pull

Key Facts:

GCD Theme: Affordable Destination Systems & Instruments (ADSI)
Execution Status: Year 4 of 4 (extended as FTE only task 4th year)
Technology Start Date: October 1, 2011
Technology End Date: May 28, 2015
Technology TRL Start: 4 **Technology TRL End:** 6
Technology Current TRL: 5
Technology Lifecycle Phase: Completed and Transitioned

NGLS Mars Atmospheric ISRU



PROBLEM / NEED BEING ADDRESSED

Develop a Mars Atmospheric Processing Module to demonstrate a scalable CO₂ Freezer and methanation process

PROJECT DESCRIPTION/APPROACH

- The multi-NASA center Mars Atmosphere and Regolith Collector/Processor for Lander Operations (MARCO POLO) project was established to build and demonstrate a methane/oxygen propellant production system in a Mars analog environment. Work at the Kennedy Space Center (KSC) has focused on the Atmospheric Processing Module (APM).
- The purpose of the APM is to
 - Freeze CO₂ from a simulated Martian atmosphere at Martian pressures (~8-10 torr) by using dual cryocoolers.
 - Feed pressurized CO₂ plus hydrogen to a Sabatier subsystem to make methane and water vapor.
- The methane would be sent to the Liquefaction Module.
- The water vapor is condensed and sent to the Water Cleanup Module (KSC) followed by the Water Processing Module (JSC), where it is electrolyzed. The resulting oxygen would be liquefied and stored and the hydrogen is sent back to the Sabatier subsystem to make more methane.
- The CO₂ freezers have been verified to meet the required 88 g CO₂/hr. collection/supply rate.
- The objectives of this task are to verify operation of the CO₂ pump and the associated storage system, complete setup and testing of the Sabatier subsystem and operate it with the CO₂ freezers to ready the APM for a potential analog demonstration with the other components of MARCO POLO.
- 12 month duration with potential for 12 month extension

QUANTITATIVE IMPACT

- Demonstrate collection of CO₂ at 88 g/hr.
- Demonstrate CO₂ conversion to methane fuel at 0.032 kg/hr. and water at 0.071 kg/hr.
- Both are rates easily scalable to robotic and crewed Mars missions, i.e. a factor of ~5 or less

PROJECT GOAL

- Advance technologies from TRL 3 to TRL 4.
- Delivery of hardware for integrated testing with other MARCO POLO modules.
- Contribute to Mars propellant production options, greatly reducing launch mass and enabling landing of much lighter payloads on Mars.
- Evolved hardware may be demonstrated on Mars 2024 Surface Pathfinder

- ~30 metric tons of propellant will be required to launch astronauts back into Mars orbit to return to Earth
- Shipping that propellant to Mars will require two SLS cargo launches
- Landing that mass on Mars is also problematic
- ISRU to make propellant on Mars needs development

- In situ propellant production is becoming a high priority requirement in TA-07
- Many years of laboratory development by NASA and SBIR companies has greatly narrowed the options
- Proof of the availability of water in the surface regolith of Mars allows for the production of both methane fuel and oxygen
- Demonstration of an end-to-end Mars ISRU system would allow confidence by mission planners

NGLS Mars Atmospheric ISRU Overview



What would you say to a Senator in an elevator?

- We are developing a process to save about 30 tonnes of mass for human Mars missions, saving billions of dollars.
- The process converts CO₂ from the Mars atmosphere and water from the Mars soil to fuel and oxygen.
- We freeze the CO₂, then convert the gas to methane and water (which is electrolyzed) with hydrogen.

Integration with other projects/programs and partnerships

- Prior and current additional funding from KSC CTC and IR&TD
- Planned cooperation with SpaceX under KSC SAA
- Modification of a Sabatier reactor developed by a NASA SBIR (Lunar Organic Waste Reformer)
- New GCD ISRU/CTC/IR&TD project leverages plans for full integrated test of MARCO POLO modules at KSC and/or JSC
- Integrated with proposed STMD Mars ISRU project

Technology Infusion Plan:

- PC
- Technology Developed: Mars Atmospheric Processing Module (APM = Integrated Mars CO₂ Freezer Subsystem and Sabatier Subsystem)
- Potential customers: HEOMD (EMC), SpaceX
- Potential use on 2024/2026 Mars Surface Pathfinder

Key Personnel:

Program Element Manager: Kevin Kempton

Project Manager: Dr. Daniel J. Barta/Koorosh Araghi

Project Element Lead: Dr. Anthony C. Muscatello

Lead Center: KSC

Supporting Centers: JSC

NASA NPR: 7120.8

Guided or Competed: Guided

Type of Technology: Push

Key Facts:

GCD Theme: Affordable Destination Systems & Instruments (ADSI)

Execution Status: Year 1 of 1

Technology Start Date: October 1, 2014

Technology End Date: September 30, 2015

Technology TRL Start: 3

Technology TRL End: 4

Technology Current TRL: 3

Technology Lifecycle Phase: Implementation (Pre-Phase A)

NGLS Continuous Electrochemical Gas Separator (eSionic) Overview



Elevator Statements

- State-of-the-art carbon dioxide removal technology is heavy and requires considerable power.
- This novel approach is based on an electrochemical membrane technology that incorporates ionic liquids. CO₂ adsorption and desorption within the ionic liquid is driven by unique oxidation and reduction reactions, and not temperature or pressure swings common to conventional methods.
- The technology uses only electricity to carryout the separation, with no moving parts or pressure drops. CO₂ can be collected for oxygen recovery.

Integration with other projects/programs and partnerships

- HEOMD – Advanced Exploration Systems
 - Our chief customer is the AES Life Support Systems Project.
- NASA Innovative Advanced Concepts (NIAC)
 - This task represents Phase II of a NIAC award that was judged “overly mature” to remain within NIAC after the Phase I work was completed.
- Industry and Academia
 - Our industry partner is eSionic, of Menlo Park, CA

Technology Infusion Plan:

- MI: A Mission Usage Agreement was signed between NGLS/GCDP and the Life Support Systems Project/AES/HEOMD 4/14/15.
- The grant was a joint effort between NGLS/GCDP and LSS/AES/HEOMD.
 - NGLS funded the first year of the 2 year grant. LSS had planned to fund the second year.
 - Personnel from both projects contributed to technical monitoring of the grant.
- The technology task was terminated after technical difficulty led to determination proof of concept was not possible.

Key Personnel:

Program Element Manager: Kevin Kempton

Project Manager: Daniel Barta

Lead Center: JSC

Supporting Centers: MSFC (assisting with technical monitoring)

NASA NPR: 7120.8

Guided or Competed: Competed

Type of Technology: Pull

Key Facts:

GCD Theme: Affordable Destination Systems & Instruments (ADSI)

Execution Status: Year 1 – Terminated

Technology Start Date: September 1, 2014

Technology End Date: June 30, 2015 (Originally planned 8/31/16)

Technology TRL Start: 2

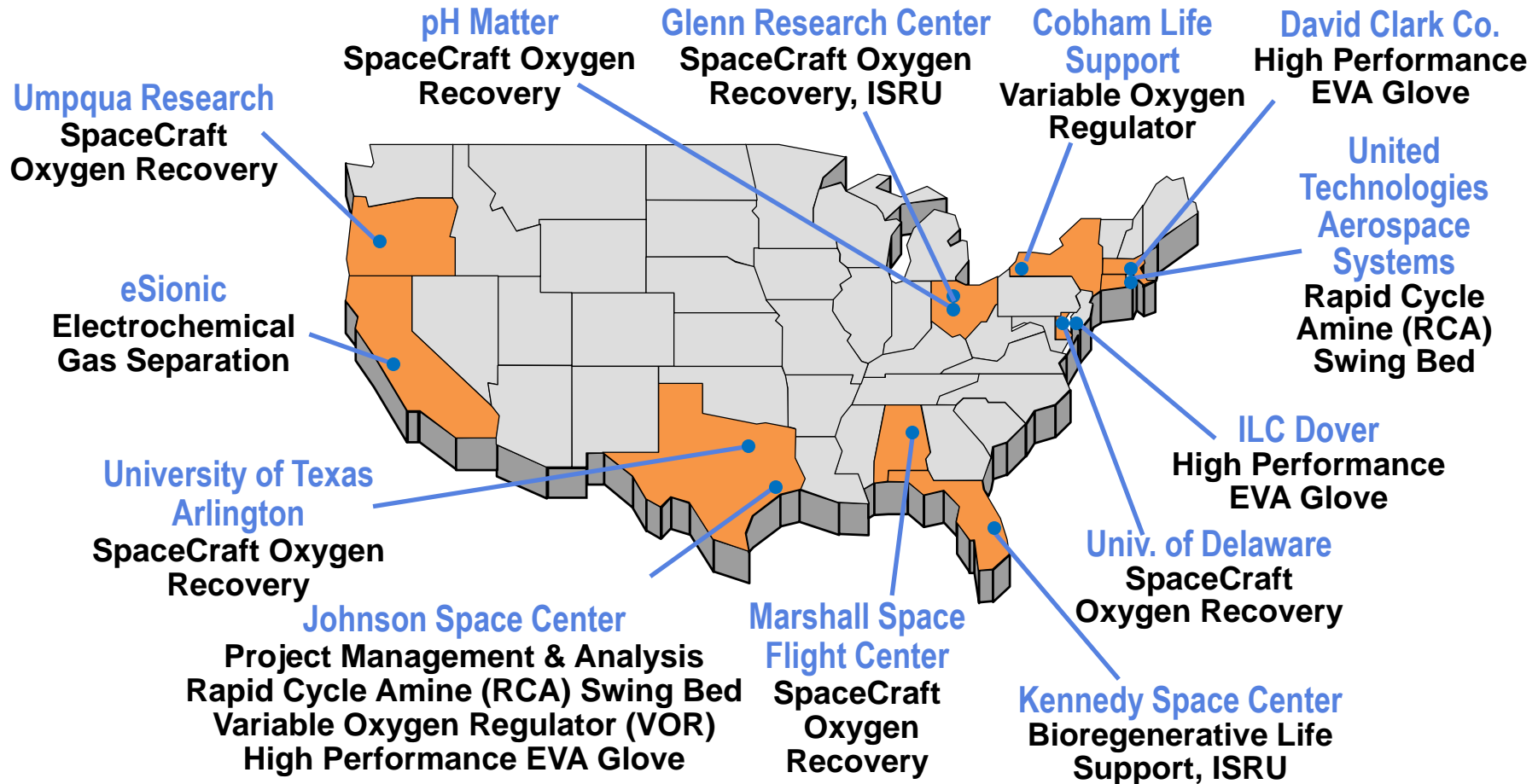
Technology TRL End: 2 (originally planned for TRL 4)

Technology Current TRL: 2 (proof of concept was not achieved)

Technology Lifecycle Phase: Close Out

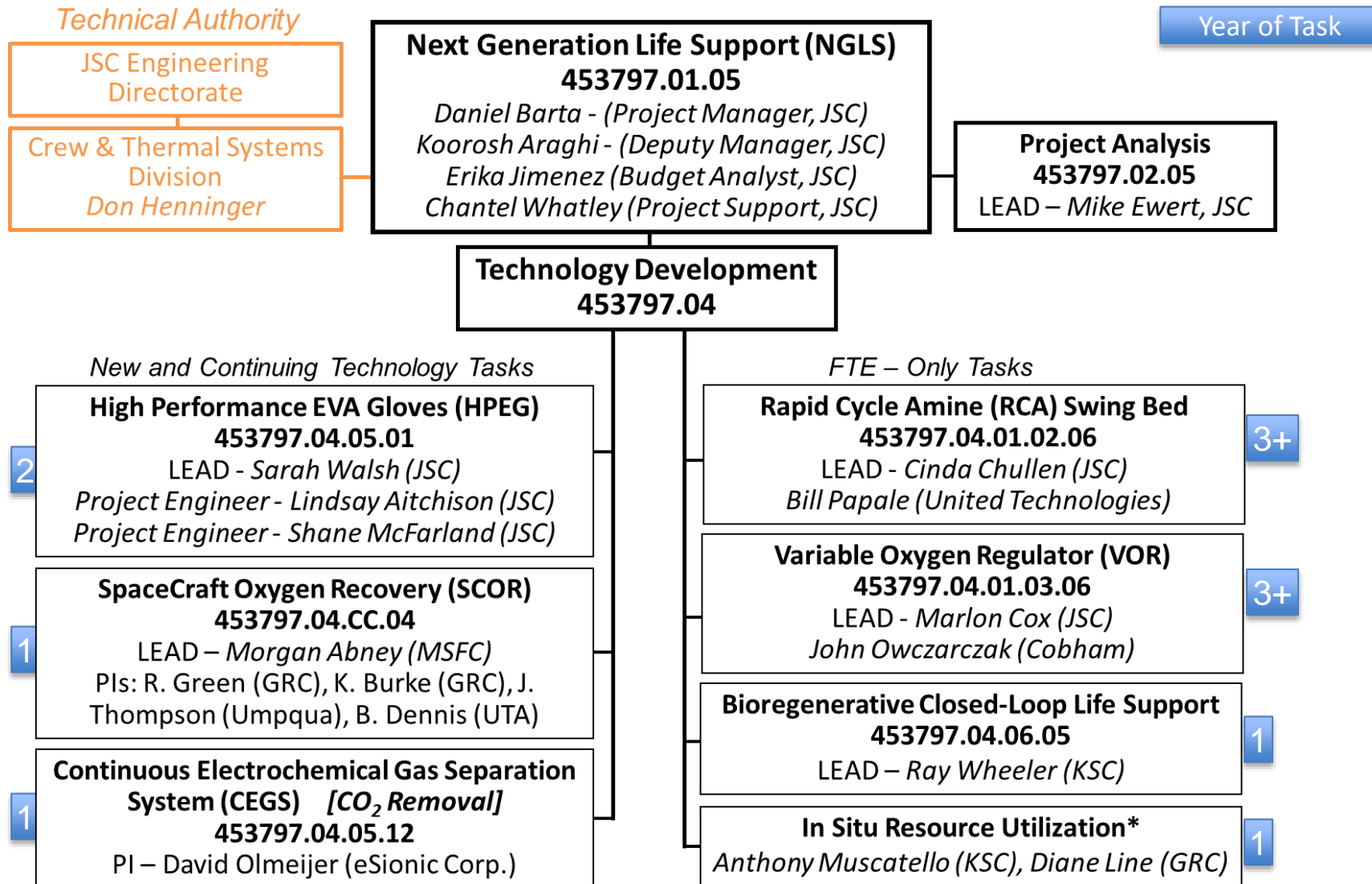


Next Generation Life Support Organization and Key Members





Next Generation Life Support FY15 Organizational Chart



CC = 2 digit field center identifier

*WBS not part of 453797, funded outside of NGLS



Next Generation Life Support Project Resources



✓ Key Milestones	Baseline Date	Actual or Replan	Comment
✓ SCOR Contract Awards	1/31/15	4/1/15	Delayed due to procurement
HPEG Sensor Glove - TRR for ambient suited testing	3/16/15	4/6/15	Delayed
PA – Tech. Comparison	4/15/15	4/15/15	Completed on time
SCOR Coordination Mtg	2/28/15	5/5-6/15	Contract award delay
HPEG Robotic Assist Glove – TRR for Glovebox Testing	5/6/15	5/6/15	2 nd of two TRRs – first was to evaluate force sensors
HPEG Thermal Analysis Rpt	3/30/15	5/28/15	Facility Availability Issue
✓ VOR 3.0 Fab, Test, Delivery	3/31/15	5/26/15	Fabrication delay
VOR Transition Review	3/31/15	5/28/15	Unit 002 delivery delayed
✓ RCA 3.0 Fab, Test, Delivery	2/13/15	6/23/15	Controller delayed
HPEG Gas Pressurized Glove – Second Contract	3/31/15	6/30/15	Reducing scope to lower value delayed procurement

Quarterly Technical Accomplishments:

- SpaceCraft Oxygen Recovery contracts were awarded April 1. The Technical Coordination was held May 5 to 6, 2015 at JSC.
- Suited testing of the HPEG sensor glove started after April 6 TRR.
- VOR 3.0 Units 001 and 002 were delivered April 16, and May 26, respectively. A successful transition Review was held May 28.
- Glovebox testing of the prototype Robotic Assist Glove was initiated after a TRR was held May 6, 2015.
- The RCA 3.0 Assembly completed assembly, verification testing and delivery on June 23, 2015. Transition Review scheduled July 9.
- A second contract for the HPEG gas pressurized glove competitive procurement was awarded June 30, 2015 to David Clark Company

Concerns:

- eSionic concept could not be proven and was terminated
- Schedule delays in VOR and RCA delivery, several HPEG milestones

Cost	Schedule	Technical	Programmatic

Resources:

- FY12: \$6.023M, FY13: \$6.778M, FY14: \$6.653M FY15: \$4.696M
- FY15 FTE: 5.17 total; JSC: 2.8, GRC: 1.7, MSFC: 0.67
- FY15 WYE: 3.25 total; JSC: 3.25, GRC: 0.95

Budget (\$M)	Q1	Q2	Q3	Q4	Total
Budget Allocation	\$4,586	\$ 110	\$ -	\$ -	\$4,696
Approved (received)	\$2,026	\$2,561	\$ -	\$ -	\$4,587
Obligated	\$ 374	\$1,165	\$1,623	\$ -	\$3,163
Costed	\$ 241	\$ 714	\$ 918	\$ -	\$1,873

Annual Budget Profile (\$K)

